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Contents

Foreword

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1 Scope

The present document specifies the security architecture, i.e., the security features and the security mechanisms for the Evolved Packet System and the Evolved Packet Core, and the security procedures performed within the evolved Packet System (EPS) including the Evolved Packet Core (EPC) and the Evolved UTRAN (E-UTRAN).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[3] 3GPP TS 23.003: "Numbering, addressing and identification".

[4] 3GPP TS 33.102: "3G security; Security architecture".

[5] 3GPP TS 33.210: "3G security; Network Domain Security (NDS); IP network layer security".

[6] 3GPP TS 33.310: "Network Domain Security (NDS); Authentication Framework (AF)".

[7] IETF RFC 4303: "IP Encapsulating Security Payload (ESP)".

[8] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic bootstrapping architecture".

[9] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".

[10] – [11] Void.

[12] 3GPP TS 36.323: "Evolved Universal Terrestrial Radio Access (E-UTRA); Packet Data Convergence Protocol (PDCP) specification"

[13] 3GPP TS 31.102: "Characteristics of the Universal Subscriber Identity Module (USIM) application".

[14] 3GPP TS 35.215: "Confidentiality and Integrity Algorithms UEA2 & UIA2; Document 1: UEA2 and UIA2 specifications"

[15] NIST: "Advanced Encryption Standard (AES) (FIPS PUB 197) "

[16] NIST Special Publication 800-38A (2001): "Recommendation for Block Cipher Modes of Operation".

[17] NIST Special Publication 800-38B (2001): "Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication".

[18] – [20] Void.

[21] 3GPP TS 36.331:"Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol specification".

[22] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[23] 3GPP TS 22.101: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; Service principles".

[24] 3GPP TS 25.331: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification ".

[25] 3GPP TS 44.060: "3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol.

[26] 3GPP TS 23.122: "3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[27] 3GPP TS 33.320: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Security of Home Node B (HNB) / Home evolved Node B (HeNB)".

[28] (void)

[29] ETSI TS 102 484 V10.0.0: "Smart Cards; Secure channel between a UICC and an end-point terminal".

[30] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[31] 3GPP TS 31.116 "Remote APDU Structure for (Universal) Subscriber Identity Module (U)SIM Toolkit applications".

[32] ETSI TS 102 221 V9.2.0: "Smart Cards; UICC-Terminal interface; Physical and logical characteristics".

[33] 3GPP TS 35.221: "Confidentiality and Integrity Algorithms EEA3 & EIA3; Document 1: EEA3 and EIA3 specifications".

[34] RFC 4301: "Security Architecture for the Internet Protocol".

[35] 3GPP TS 22.346: "Isolated Evolved Universal Terrestrial Radio Access Network (E-UTRAN) operation for public safety; Stage 1".

[36] 3GPP TS 33.210: "3G security; Network Domain Security (NDS); IP network layer security".

[37] 3GPP TS.33.310: "Network Domain Security (NDS); Authentication Framework (AF)".

[38] IETF RFC 7296: " Internet Key Exchange Protocol Version 2 (IKEv2)".

[39] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std.".

[40] 3GPP TS 36.463: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and Wireless LAN (WLAN); Xw application protocol (XwAP)".

[41] 3GPP TS 33.402: "3GPP System Architecture Evolution (SAE); Security aspects of non-3GPP accesses".

[42] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[43] 3GPP TS 33.501: "Security architecture and procedures for 5G system".

[44] 3GPP TS 38.300: "NR; Overall description; Stage-2".

[45] 3GPP TS 36.423: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 33.102 [4] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Access Security Management Entity: entity which receives the top-level keys in an access network from the HSS. For E-UTRAN access networks, the role of the ASME is assumed by the MME

Activation of security context: the process of taking into use a security context.

Authentication data: Data that is part of a security context or of authentication vectors.

Chaining of K_{eNB}: derivation of a new K_{eNB} from another K_{eNB} (i.e., at cell handover)

Current EPS security context: The security context which has been activated most recently. Note that a current EPS security context originating from either a mapped or native EPS security context may exist simultaneously with a native non-current EPS security context.

ECM-CONNECTED state: This is as defined in TS 23.401 [2]. The term ECM-CONNECTED state corresponds to the term EMM-CONNECTED mode used in TS 24.301 [9].

ECM-IDLE state: As defined in TS 23.401 [2]. The term ECM-IDLE state corresponds to the term EMM-IDLE mode used in TS 24.301 [9].

EPS-Authentication Vector: K_{ASME}, RAND, AUTN, XRES

EPS security context: A state that is established locally at the UE and a serving network domain. At both ends "EPS security context data" is stored, that consists of the EPS NAS security context, and the EPS AS security context.

NOTE 1: An EPS security context has type "mapped", "full native" or "partial native". Its state can either be "current" or "non-current". A context can be of one type only and be in one state at a time. The state of a particular context type can change over time. A partial native context can be transformed into a full native. No other type transformations are possible.

EPS AS security context: the cryptographic keys at AS level with their identifiers, the Next Hop parameter NH, the Next Hop Chaining Counter parameter NCC used for next hop access key derivation, the identifiers of the selected AS level cryptographic algorithms, counters used for replay protection and SCG Counter used as freshness input into S-K_{eNB} derivations. Note that the EPS AS security context only exists when cryptographically protected radio bearers are established and is otherwise void.

NOTE 2: NH and NCC need to be stored also at the MME during connected mode.

EPS AS Secondary Cell security context: This context consists of the cryptographic keys for SeNB (K_{UPenc}), the identifier of the selected AS SC level cryptographic algorithm and counters used for replay protection.

EPS NAS security context: This context consists of K_{ASME} with the associated key set identifier, the UE security capabilities, and the uplink and downlink NAS COUNT values. In particular, separate pairs of NAS COUNT values are used for each EPS NAS security contexts, respectively. The distinction between native and mapped EPS security contexts also applies to EPS NAS security contexts. The EPS NAS security context is called "full" if it additionally contains the keys K_{NASint} and K_{NASenc} and the identifiers of the selected NAS integrity and encryption algorithms.

Full native EPS security context: A native EPS security context for which the EPS NAS security context is full according to the above definition. A full native EPS security context is either in state "current" or state "non-current".

Forward security: In the context of K_{eNB} key derivation, forward security refers to the property that, for an eNB with knowledge of a K_{eNB}, shared with a UE, it shall be computationally infeasible to predict any future K_{eNB}, that will be used between the same UE and another eNB. More specifically, n hop forward security refers to the property that an eNB is unable to compute keys that will be used between a UE and another eNB to which the UE is connected after n or more handovers (n=1 or 2).

IAB-node: As defined in TS 23.401 [2].

IAB-donor: As defined in TS 23.401 [2].

Legacy security context: A security context which has been established according to TS 33.102 [4].

Mapped security context: Security context created by converting the current security context in the source system to a security context for the target system in inter-system mobility, e.g., UMTS keys created from EPS keys. The EPS NAS security context of a mapped security context is full and current.

Native EPS security context: An EPS security context whose K_{ASME} was created by a run of EPS AKA.

Non-current EPS security context: A native EPS security context that is not the current one. A non-current EPS security context may be stored along with a current EPS security context in the UE and the MME. A non-current EPS security context does not contain an EPS AS security context. A non-current EPS security context is either of type "full native" or of type "partial native".

Partial native EPS security context: A partial native EPS security context consists of K_{ASME} with the associated key set identifier, the UE security capabilities, and the uplink and downlink NAS COUNT values, which are initially set to zero before the first NAS SMC procedure for this security context. A partial native EPS security context is created by an EPS AKA, for which no corresponding successful NAS SMC has been run. A partial native context is always in state "non-current".

Re-derivation of NAS keys: derivation of new NAS keys from the same K_{ASME} but including different algorithms (and no freshness parameter)

Refresh of K_{eNB}: derivation of a new K_{eNB} from the same K_{ASME} and including a freshness parameter

Re-keying of K_{eNB}: derivation of a new K_{eNB} from a new K_{ASME} in ECM-CONNECTED (i.e., . to activate a partial native EPS security context, or to re-activate a non-current full EPS security context)

Re-keying of NAS keys: derivation of new NAS keys from a new K_{ASME}

UE security capabilities: The set of identifiers corresponding to the ciphering and integrity algorithms implemented in the UE. This includes capabilities for EPS AS and NAS, and includes capabilities for UTRAN and GERAN if these access types are supported by the UE.

UE EPS security capabilities: The UE security capabilities for EPS AS and NAS.

User plane: Within the context of TS 33.401, this means the data path between UE and Serving Gateway that does NOT go via the MME.

(User) Data via MME: User Data sent to or from the UE that uses an RRC connection established using the Control Plane CIoT EPS optimisation specified in TS 23.401[2].

IOPS-capable eNB: an eNB that has the capability of IOPS mode operation, which provides local IP connectivity and Public Safety services to IOPS-enabled UEs via a Local EPC when the eNB has lost backhaul to the Macro EPC or it has no backhaul to the Macro EPC.

IOPS network: an IOPS network consists of one or more eNBs operating in IOPS mode and connected to a Local EPC.

Local EPC: a Local EPC is an entity which provides functionality that eNBs in IOPS mode of operation use, instead of the Macro EPC, in order to support Public Safety services**.**

Macro EPC: the EPC which serves an eNB when it is not in IOPS mode of operation.

Nomadic EPS: a deployable system which has the capability to provide radio access (via deployable IOPS-capable eNB(s)), local IP connectivity and Public Safety services to IOPS-enabled UEs in the absence of normal EPS.**IOPS-enabled UE:** is an UE that is configured to use networks operating in IOPS mode.